Oct. 17, 1933. W. H. TAYLOR 1,930,569

ICE MAKING APPARATUS

Original Filed Oct. 13, 1930 3 Sheets-Sheet 1

Fig. 1

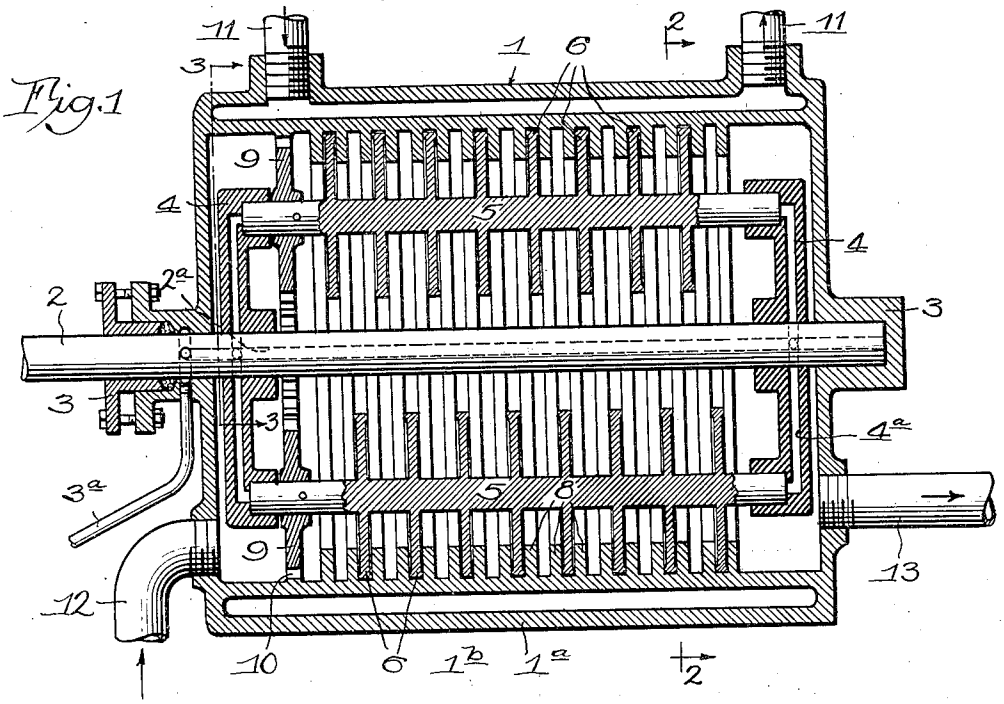


Fig. 2

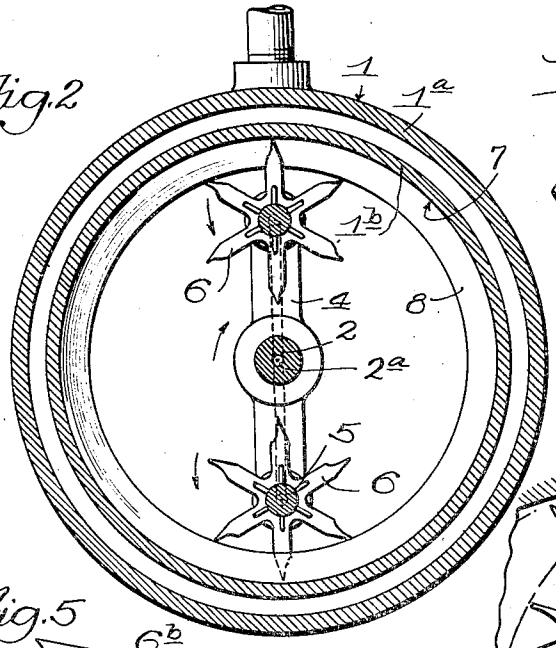


Fig. 3

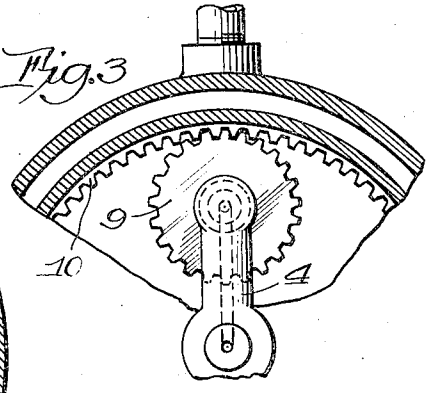


Fig. 4

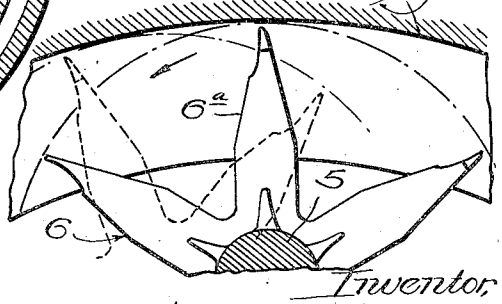
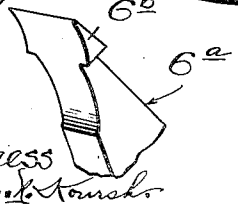


Fig. 5



Witness
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ICE MAKING APPARATUS

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Fig. 6

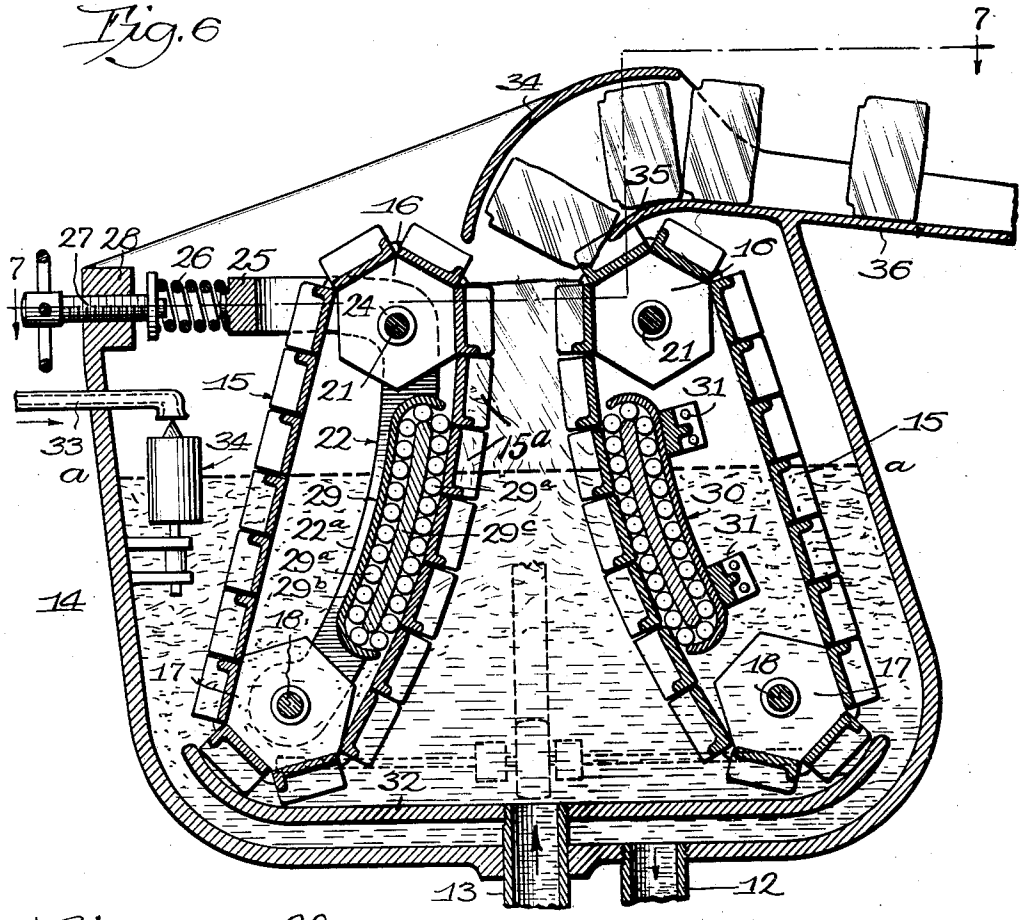
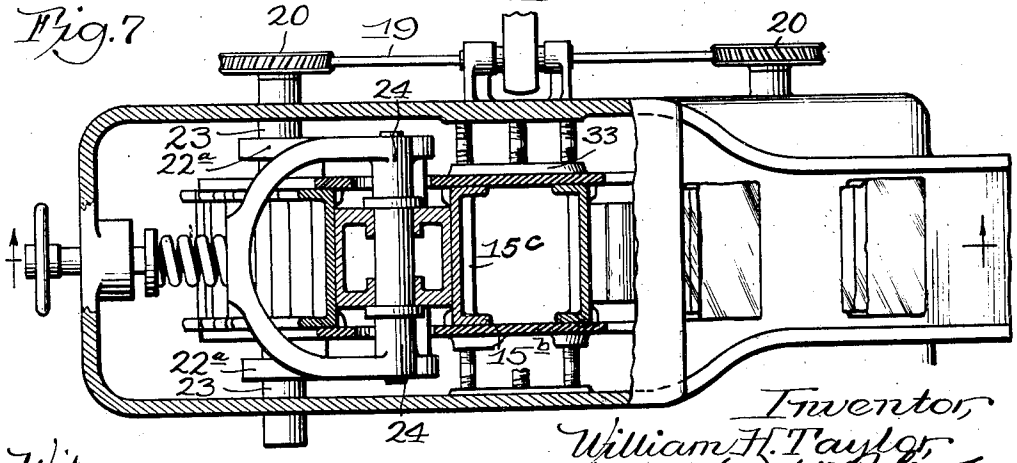


Fig. 7



Witness:
Chas. L. Kousek

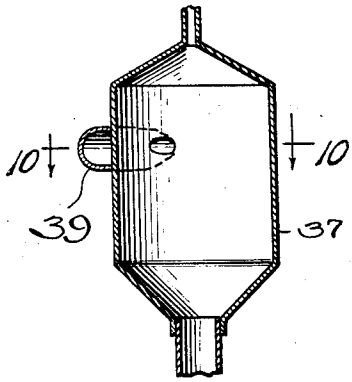
Inventor,
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Fig. 9



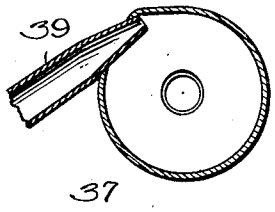
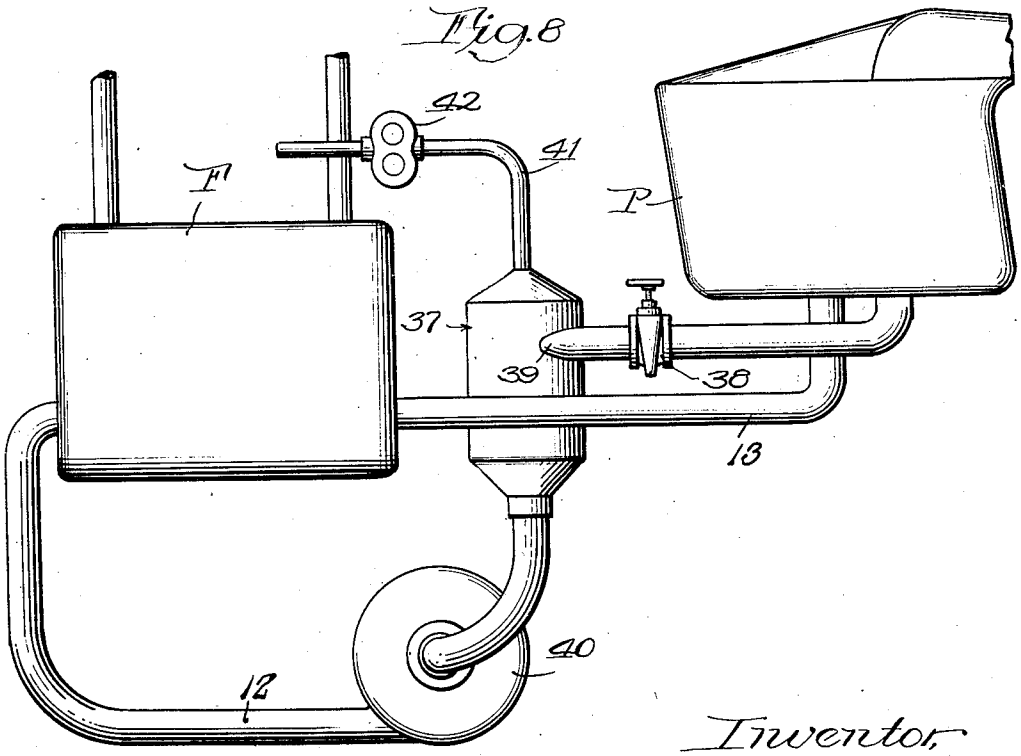


Fig. 10

Fig. 8



Witness:
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Patented Oct. 17, 1933

1,930,569

UNITED STATES PATENT OFFICE

1,930,569

ICE MAKING APPARATUS

William H. Taylor, Milwaukee, Wis., assignor to The Vilter Manufacturing Company, Milwaukee, Wis., a corporation of Wisconsin

Application October 13, 1930. Serial No. 488,295
Renewed January 16, 1932

20 Claims. (Cl. 62—108)

This invention relates to improvements in ice making apparatus, and more particularly to machines for commercial production of ice for refrigerating purposes by a so-called continuous process as distinguished from the intermittent process more commonly employed and consisting generally of freezing the water in tanks or containers.

The operation performed by the present apparatus is briefly that of forming a slush-like mass of ice particles in a mechanical freezer, and then compressing the soft mass into a solid form. This process broadly is not a new one, but as is the case in many branches of the mechanical arts, the superiority of the new process or machine over the old is not always demonstrable either because of faulty design of the apparatus, or the inability to operate at a sufficient saving in the cost of manufacture to justify its general adoption.

Thus in the present instance, the principle of the continuous process is believed to be sound, and it only remains to perfect the apparatus to a higher degree of efficiency to make it entirely practical. The object, therefore, of the present invention is to improve upon the apparatus used in the manufacture of ice by the continuous process to such an extent as to make it more practical and commercially useful.

A preferred embodiment of the invention is disclosed in the accompanying drawings, in which

Figure 1 is a view in vertical section through the freezer.

Figure 2 is a view in cross section through the freezer taken on line 2—2 of Figure 1.

Figure 3 is a detail view in cross section taken on line 3—3 of Figure 1.

Figure 4 is an enlarged detail view of a portion of one of the cutters.

Figure 5 is a perspective view of the end of one of the cutting teeth.

Figure 6 is a general view in vertical section through the press.

Figure 7 is a view in horizontal section through the press as taken on line 7—7 of Figure 6.

Figure 8 is a diagrammatic view showing the connections between the freezer and the press.

Figure 9 is a view in vertical section through the air-removing device, and

Figure 10 is a view in cross section through the air-removing device taken on line 10—10 of Figure 9.

The essential parts of the apparatus or machine comprise a freezer F and a press P shown in Figure 8 as separate but inter-connected units. As their names suggest, the freezer makes the ice and the latter works or compresses it into solid form.

Referring first to the freezer (Figures 1 to 5), the same comprises a cylindric tank or container 1 having double cylindric walls 1*a* and 1*b* forming a space or jacket surrounding the freezing compartment. Extending axially of the tank is a driven shaft 2 journalled in bearings 3, 3 in the end walls of the tank and driven by a motor or other source of power (not shown).

Mounted on the central shaft 2 adjacent opposite ends of the freezing chamber are radially extending spiders 4, 4 which support counter shafts 5, 5 disposed diametrically opposite each other and journalled in bearings at the ends of said spiders. Along each of the counter shafts is a series of cutting wheels 6, 6 which travel in grooves 7 upon the internal surface of the freezing chamber and formed between annular ribs or fins 8 integral with the inner cylindric wall 1*b* surrounding said chamber. These cutting wheels move bodily in circular paths in their respective grooves with the central shaft, and also rotate with their counter shafts, the latter being driven from the central shaft 2 by means of gearing consisting of spur gears 9, 9 mounted on the ends of the counter shafts adjacent the driving end of the central shaft and which mesh with a large internal gear 10 on the inner wall 1*b* of the freezing compartment (Figure 3). Thus as the central shaft is rotated in a clockwise direction at a predetermined speed, the counter shafts 5, 5 with their cutting wheels 6 are driven in the opposite or counter-clockwise direction, the speed of the central shaft and that of the counter shafts being determined by experiment and trial to be productive of the most efficient operation as will be hereinafter discussed at greater length.

The several shaft bearings must necessarily be lubricated, but since oil would contaminate the water, it is preferred to use water under pressure as the lubricating medium. Thus the main shaft 2 has a central duct 2*a* with branches 4*a* leading through the radial arms of the spiders 4, 4 to the bearings for the counter shafts. The main duct 2*a* connects with a small pipe 3*a* leading to the shaft bearing 3 at the driving end of the shaft, through which water is pumped under pressure to the several bearings, as shown in Figure 1.

Referring in greater detail to the cutting wheels, it is to be first observed that those on one counter shaft operate in alternate grooves,

and those on the other shaft in the intermediate grooves, that is, the cutting wheels are staggered with respect to the axis of the central shaft. The cutting wheels are preferably integral with the shaft and consist of radial cutting teeth 6*a* (six in number) tapering to a sharp cutting edge at their ends. Adjacent the cutting edges the forward or leading edges of the teeth are slightly concave, the arc of concavity being approximately tangential to the radial center line of the tooth as shown in Figure 4. Moreover, each tooth at its extremity is slightly wider than the shank portion, thereby forming a cutting head 6*b* (Figure 5) which is approximately equal to the width of the groove, while there is a substantial clearance elsewhere between the teeth and the sides of the grooves, which have a depth slightly greater than one-half the length of the teeth.

Now, there is circulated through the outer jacket between the cylinder walls 1*a*, 1*b* brine or other refrigerating medium which enters and leaves through pipe connections 11, 11 with the jacketing space. In this manner the grooved surface of the freezing chamber is maintained at a low temperature, say, at zero Fahrenheit, so that water circulating through the chamber will freeze and gradually build up a film on the surfaces of the grooves, the thickness of the film being dependent upon the rate at which it is removed by the cutting wheels.

Referring to the cutting action of a single wheel, it is apparent that during the interval of its bodily rotation about its groove that a film of ice builds upon the bottom and sides thereof to a thickness of, say, $\frac{1}{8}$ of an inch. Now, each tooth travels in an arc as it enters and leaves the groove, and with each rotation of the cutter it cuts or chisels out a thin layer of the ice film at several points about the groove, the action of each cutting wheel being similar to that of a milling cutter removing the metal in a milling operation. Thus each entering cutting tooth removes a relatively thin layer from the sides of the grooves as well as at the bottom, and carries it outwardly into the freezing chamber, so that the action of each wheel is a succession of cutting or chipping operations by the individual teeth as the wheel travels about the groove. It is to be observed, however, that the cutting wheels are driven through the gearing heretofore described, so that the rotation of the wheels is not in the nature of a rolling contact with the surface of the grooves, but a positive driving action at a predetermined speed, which for the purpose of this disclosure may be assumed to be slightly faster than a rolling motion. In other words, the cutter teeth are advanced through a small angle with each revolution so that the cut taken by each tooth is just ahead of the point where the preceding cut was made. Consequently the ice is chipped out of the grooves in small increments and as rapidly as it is formed.

It is further to be noted that the cutting teeth have considerable clearance at the bottom of the grooves, which may be as much as 1/64 of an inch, the purpose being to avoid cutting the film to the very surface of the metal, but rather leaving a thin film which is somewhat roughened by the cutting action upon which the new ice formation may build, it being known that ice will form more rapidly on a roughened surface of ice than upon a smooth surface of metal.

At this point it may be desirable to explain that the action of the cutting wheels is essentially different from the scraping of ice from the smooth surfaces of a container as has heretofore been the practice. In the first place, the amount of ice which can be obtained is greatly increased by the grooving of the freezing chamber, it being estimated that the effective area is nine times greater than a plain cylindric surface of the same length and diameter. Again, the use of cutting wheels in place of a scraper is far more efficient, inasmuch as the ice is removed by actually cutting or chipping the ice, rather than a scraping action, as by a blade, which requires greater power. Thus these features of design make it possible to increase the production of ice with a considerably smaller apparatus and decrease in the power necessary to drive it.

As already suggested, a continual circulation of water is maintained through the freezing chamber, being forced in under pressure through an inlet pipe 12, connected with one end of the chamber and leaving through a discharge pipe 13 connected with the opposite end. It is estimated that the rate of flow of water through the freezer is some twenty times the quantity that is frozen during a given period of operation, so that there is an adequate flushing action maintained to carry off the ice particles which are discharged from the grooved surface. The moving parts within the chamber are rotated at a fairly high speed, and therefore an appreciable centrifugal action is set up, which serves to carry the ice particles rapidly from the grooves and bring the water into contact with the surfaces of the grooves.

Manifestly the ice particles are carried from the chamber through the discharge pipe 13, in the stream of cold water which is continually being circulated and recirculated through the freezer having in the meantime passed through the press where the ice particles are compressed into solid form, and then returned to the freezer where a certain percentage is constantly being solidified to replace that already frozen and removed by the cutters.

Referring now to Figures 6 and 7, the press consists generally of an elongated open tank or receptacle 14 into which the mixture of water and ice particles are received from the freezer. Mounted within the tank are the compressing elements consisting of two endless belts 15, 15 converging toward each other from the bottom of the tank, the two active leads of the belts, namely, those facing each other, forming the sides of a conical-shaped pressure zone. The belts are made up of a plurality of plates 15*a* hinged together and supported upon pairs of upper and lower sprocket wheels 16, 16 and 17, 17, the lower sprockets being spaced at a considerably greater distance apart than the upper sprockets, so that the inner or active leads of the belts converge toward each other from bottom to top. The lower sprocket wheels 17, 17 are mounted on transverse shafts 18, 18 journalled in suitable bearings on the side walls of the receptacle, and extended at one end exterior the receptacle for connection with a suitable drive, such as a belt-driven shaft 19, driving worm wheels 20, 20 on the sprocket wheel shafts as shown in Figure 7.

The upper sprocket wheels 16, 16 are similarly mounted on shafts 21, 21 journalled in bearings at each end, the bearings for the right-hand shaft (Figure 6) being fixed while the left-hand shaft has bearing in an adjustable bracket 22 permitting the active leads of the belts to shift toward and from each other to compensate for different conditions of operation, as will be presently dis-

cussed in greater detail. The bracket consists of two curved branches or arms 22*a*, 22*a* extending generally in alignment with the inner or active leads of the belt, and having bearing at their lower ends on the bearing sleeves 23, 23 for the drive shaft 18 of the lower sprocket wheel. At the upper ends of these arms are mounted the bearings 24, 24 for the upper sprocket shaft 21, and at these points the branches are united by a yoke 25 extending laterally toward the adjacent end of the receptacle and at the level of the upper edge thereof. Bearing against the central point of the yoke is a heavy compression spring 26 backed by an adjusting screw 27 threaded through a bearing block 28 integral with the end wall of the receptacle.

Immediately behind the active lead of the left-hand belt 15 is a roller thrust bearing 29 carried by the arms 22*a*, 22*a* of the bracket 22, and extending substantially the length thereof between the two sprocket wheels 16 and 17. This bearing consists of a multiplicity of rollers 29*a* retained within a cage consisting of an outer track 29*b* and an inner track 29*a*, the former being a plate with curved ends and the latter a slightly thicker plate parallel with the outer track and located between the same and the rear face of the belt. The rollers fill the trackway between the track members, rolling in an elongated circuitous path with the movement of the belt. A similar roller thrust bearing 30 is located behind the active lead of the opposite belt 15, but in this instance is supported by means of brackets 31, 31 fastened to the sides of the receptacle.

The pressure required to compress the more or less fluid mass of ice into a solid state is considerable, and hence the necessity for backing the plates with some type of anti-friction bearings such as those disclosed, in order to reduce the load on the driving mechanism. Moreover the provision of a yieldable adjustment by mounting one of the belts on the pivoted bracket 22, is desirable, in order to maintain a constant pressure on the mass in case there should be a variation in the volume of ice entering the pressure zone. In other words, the pressure belts would be set to handle a given amount of ice delivered from the freezer, that is the normal capacity of the freezer, but should the volume increase, the density of the solid ice would remain the same, inasmuch as the movable belt would shift bodily in order to increase the capacity of the pressure zone and thus relieve the excessive strain on the mechanism.

At the bottom of the receptacle and between the lower ends of the pressure belts 15, 15 and the bottom wall is a partition plate or wall 32 having its end edges curved upwardly to conform with the path of the belts and terminating short of the end walls of the receptacle to provide openings between the spaces above and below said partition plate. Extending upwardly through the bottom wall of the receptacle and opening through the partition plate 32 at the center of the space included between the opposite leads of the belt 15, 15 is the discharge end of the intake pipe 13 from the freezer through which is conducted the mixture of water and ice particles continually being flushed therefrom.

Just to one side of the intake pipe 13 is the outlet end of the return pipe 12 which connects with the space below the partition plate 32, and eventually leads to the freezer. Provision is made for feeding fresh water to the receptacle through a pipe 33 leading from a suitable source of supply, and entering near the top thereof, the flow being controlled by a suitable float valve 34 adapted to maintain a predetermined water level in the receptacle as indicated by the dotted line *a*—*a* in Figure 6, this level being substantially one-half the depth of the receptacle.

The links 15*a* of the belts 15 consist of flat plates flanged as at 15*b* along their longitudinal or end edges so that they are channel shape in transverse section with the flanges projecting toward each other along the active leads of the belts. Moreover, each plate is provided with a shorter transverse flange 15*c* which is located along their lower edges as they move upwardly as part of the inner or active leads of the belts. As shown in Figure 7, the tank is considerably wider than the plates which make up the belts 15, 15 in order to accommodate the parts associated therewith, and therefore to close the ends of the space included between the opposing leads of the belts, vertical plates 33, 33 are mounted in the tank so that their faces are substantially flush with the flanged edges of the plates.

Having described the construction of the press, its operation will be understood from the following discussion:

The mixture of water and ice entering the bottom of the receptacle fills the space between the pressure belts which are moving continuously at a slow rate of speed in an upward direction. The mass of ice being in a semi-fluid condition, becomes gradually compressed between the two leads of the belt as they converge toward the water level in the tank, the water being squeezed out through the spaces between the plates. Thus as the mass of ice emerges above the water level in the receptacle, it has been compressed into a solid mass in the form of a vertical moving column. At intervals along the column the transverse flanges 15*c* of the plates form crevices which serve to aid in the breaking of the mass into blocks, this being accomplished by guiding the moving column into a curved trackway formed between walls 34 and 35 curving through approximately 90°, the lower curved wall forming the inner end of a chute 36 extending laterally with a slight downward inclination from the receptacle. Thus as the column of ice is discharged from the pressure belt, it strikes the curved trackway and is broken in blocks *b* along lines weakened by the crevices, and are discharged by gravity along the chute.

Now the water which is removed from the ice mass as it is compressed to solid form, is eventually returned to the freezer from the tank of the press through the pipe 12 which discharges from the bottom of the tank below the partition plate 32.

Figure 8 illustrates diagrammatically the complete circulating system which by preference includes an auxiliary apparatus for removing the air from the water entering the freezer. Thus indicating the freezer as F and the press as P, the pipe 13 is shown as leading directly to the press from the freezer. The return pipe 12, however, is led first to a vertical drum 37 having conical end portions entering the same through a valve 38 and a nozzle-like fitting 39, arranged tangentially with respect to the cylindric wall of the drum and located near its upper end. Connected with the bottom of the drum is a continuation of the return pipe 12 leading to a driven pump 40, and thence to the freezer. From the upper end of the drum is a small pipe 41 leading to a small air pump 42 which continually

pumps the air from the drum as it is liberated from the water by the agitation to which the same is subjected on entering the drum. The valve 38 is adjusted so that a slight vacuum is maintained within the drum by the action of the air pump just and sufficient to prevent the water to be drawn out with the air, this being determined at the point where water ceases to drip from the end of the air discharge pipe 41. The water thus pumped into the freezer from the drums is free from air bubbles and as a result the frozen ice particles are clear as are the blocks *b* after the ice has been compressed.

The apparatus thus described as consisting of the several connected units is capable of producing ice at a relatively low cost owing to the reduced size of the units and the minimum of power required to drive it, compared with the volume of water that is being continually frozen and compressed into block form.

Manifestly certain departures from the disclosed apparatus may be employed without departing from the spirit of the invention, as for example the elimination of the block-forming means, so that the ice issues from the press in a solid column, to then be cut or sawed into blocks by any suitable cutter.

I claim as my invention:

1. In an ice making apparatus, the combination of a freezer comprising a container having a cylindric wall maintained at a freezing temperature, the inner surface of said wall being provided with annular grooves, a driven shaft extending axially of said container, cutting wheels carried by said shaft and adapted to ravel within said grooves in the rotation of said shaft and means for rotating said cutting wheels relative to said shaft.

2. In an ice making apparatus, the combination of a freezer comprising a container having a cylindric wall maintained at a freezing temperature, the inner surface of said wall being provided with grooves, a shaft extending axially of said container and provided with radial bearing members, cutting elements journalled in said bearing members and consisting of wheels having radial cutting teeth adapted to project into said grooves, means for rotating shaft and means driven by said shaft for imparting a predetermined relative rotation to said cutting elements.

3. In an ice making apparatus, the combination of a freezer comprising a container having a cylindric wall subjected to a freezing temperature, the inner surface of said wall being provided with grooves, a driven shaft extending axially of said container and provided with radial bearing members, cutting elements journalled in said bearing members and consisting of wheels having radial cutting teeth adapted to project into said grooves, and gearing interposed between said shaft and said cutting elements to impart a predetermined relative rotation thereto.

4. In an ice making apparatus, the combination of a freezer having a cylindric wall surrounding the freezing compartment and provided with a multiplicity of internal radial ribs spaced apart to form annular grooves throughout the length thereof, a driven shaft extending axially of said container and provided with radial arms, a counter-shaft journalled in said arms, cutters spaced apart along said counter-shaft, each cutter travelling about one of said grooves in the rotation of said shaft, and gearing interposed between said shaft and counter-shaft for imparting a relative rotation to said cutters.

5. In an ice making apparatus, the combination of a closed container having inner and outer cylindric walls spaced apart to form a jacket with inlet and outlet connections for the circulation of a refrigerating medium, said inner wall having a multiplicity of integral inwardly projecting ribs forming annular grooves arranged longitudinally of the internal space of said container, a driven shaft extending axially of said container, a plurality of cutting elements journalled in radial bearing members carried by said shaft, said elements comprising cutting wheels each travelling in a circular path in one of said grooves, and each consisting of a set of radial teeth, means for circulating water through said container and means for imparting a predetermined speed of rotation to said cutting wheels whereby the film of ice formed on the surfaces of said grooves is continually removed in small particles.

6. In an ice making apparatus, the combination of a freezer comprising a refrigerated container, means for circulating water through said freezer, means for cutting the ice formed on the surface of said container and reducing it to small particles, a press comprising a tank having an inlet connection from said freezer, and a pair of driven belts converging toward each other from the bottom of said tank above the inlet from said freezer and operative to compress the ice to solid form between the opposing leads thereof.

7. In an ice making apparatus, the combination of a freezer operating continuously to produce a semi-fluid mixture of ice and water, and a press comprising a tank in which said mixture is discharged from said freezer, a pair of driven compressing elements mounted in said tank and consisting of hinged plates forming endless belts arranged on opposite sides of a vertical space above the inlet from said freezer, the opposite leads of said belts moving vertically along converging paths whereby the ice-content of said mixture is compressed to solid form and discharged from the tank.

8. In an ice making apparatus, the combination of a freezer, a press comprising a tank connected with said freezer, a pair of pressure belts mounted in said tank on opposite sides of a space converging from the inlet from said freezer and means permitting the relative bodily shifting of said belts to equalize the volume of the space to the mass of ice being compressed.

9. In an ice making apparatus, the combination of a freezer and a press having inlet and return connections with said freezer and comprising a tank, a pair of pressure belts mounted in said tank, each consisting of a plurality of pressure plates hinged together and mounted on sprocket wheels arranged vertically of the tank so that the active leads of said belts converge toward each other from the bottom toward the top of said tank and enclose a space above the inlet opening from said freezer, and means for driving said belts.

10. In an ice making apparatus, the combination of a freezer and a press having inlet and return connections with said freezer, and comprising a tank, a partition plate extending across the bottom of said tank, a pair of driven pressure belts mounted above said partition plate and comprising a series of hinged pressure plates carried on sprocket wheels arranged to guide the opposing leads of said belts in upward converging paths, and enclosing a conical space between opposite walls of said tank, said inlet connection from said freezer opening through said partition

plate and centrally of the lower portion of said space, and means above said belts for reducing the compressed ice to block forms.

11. In an ice making apparatus, the combination of a freezer and a press having inlet and return conections with said freezer, and comprising a tank, a pair of driven pressure belts mounted on sprockets journalled in said tank and comprising series of hinged plates extending transversely between vertical walls of said tank, said belts extending upwardly from the bottom of said tank with their opposing leads converging toward each other, a bracket pivotally mounted adjacent the bottom of said tank and supporting one of said belts and permitting it movement relative to the opposite belt to vary the distance therebetween, and a spring acting on said brackt to resist the movement thereof.

12. In an ice making apparatus, the combination of a freezer and a press having inlet and return connections with said freezer, and comprising a tank, a pair of driven pressure belts mounted on sprockets journalled in said tank and comprising series of hinged plates extending transversely between vertical walls of said tank and having one of their transverse edges flanged, said belts extending upwardly from the bottom of said tank with their opposing leads converging toward each other, and curved trackway above the ends of said belts and adapted to receive the column of ice issuing therefrom and to break the same into blocks at the crevices formed in said column by the flanged edges of said plates.

13. In an ice making apparatus, the combination of a freezer comprising a cylindric wall adapted to be maintained at a freezing temperature and having a plurality of circumferential grooves in one surface thereof, means for feeding water into contact with the grooved surface of said wall, a plurality of cutting elements projecting into said grooves, driving means for imparting a relative rotation between said cylindric wall and said cutting elements whereby the latter travel in a circular path within said grooves, and means for imparting rotation to said cutting elements relative to their bodily movement within said grooves.

14. Ice making apparatus comprising, a casing having a wall provided with internal annular grooves the surfaces of which are maintained at freezing temperature, an ice-film removing member movable within said casing along and in close proximity to said groove surfaces, and means for circulating liquid through said casing in sufficient quantity to maintain said surfaces in flooded condition and to effect constant discharge of the removed ice films with the excess liquid.

15. Ice making apparatus comprising, a casing having a stationary wall provided with internal annular grooves the surfaces of which are maintained at freezing temperature, an ice-film removing member rotatable within said casing about the axis of annularity of said grooves and movable along and in close proximity to said groove surfaces, and means for circulating liquid through said casing in sufficient quantity to maintain said surfaces in flooded condition and to effect constant discharge of the removed ice films with the excess liquid.

16. Ice making apparatus comprising, a casing having a wall provided with internal annular grooves, means cooperating with said wall to maintain the surfaces of said grooves at freezing temperature, means for producing a flow of liquid over said grooves in quantities greater than necessary to produce the desired amount of ice, an ice-film removing member movable within said casing along and in close proximity to said groove surfaces, and means for constantly discharging the removed ice film mixed with excess liquid traversing said grooves.

17. Ice making apparatus comprising, a casing having a wall provided with internal annular grooves, means cooperating with said wall to maintain the surfaces of said grooves at freezing temperature, means for producing a flow of liquid over said grooves in quantities greater than necessary to produce the desired amount of ice, an ice-film removing member rotatable within said casing about the axis of annularity of said grooves and movable along and in close proximity to said groove surfaces, and means for constantly discharging the removed ice film mixed with excess liquid traversing said grooves.

18. Ice making apparatus comprising, a casing having a wall provided with an annular internal substantially corrugated surface, means for maintaining said surface at freezing temperature, means for producing free circulation of liquid over and along the corrugations of said surface in sufficient quantities to maintain the entire surface flooded with a moving mass of the liquid, an ice-film remover movable in close proximity to all portions of said surface, and means for utilizing the excess liquid traversing said surface to deliver the removed ice film from said casing.

19. Ice making apparatus comprising, a casing having a wall provided with an annular internal surface generated about a substantially horizontal axis, means for subjecting said wall to the direct action of gaseous refrigerant, means for freely circulating water horizontally along said surface, an ice-film remover revolvable about said axis in close proximity to said surface, and means for utilizing the excess water to discharge the removed ice-film.

20. Ice making apparatus comprising, a casing having a wall provided with an annular internal surface generated about a substantially horizontal axis, means for subjecting said wall to the direct action of gaseous refrigerant, means for freely circulating water horizontally along said surface, an ice-film remover revolvable about said axis in close proximity to said surface, means for utilizing the excess water to discharge the removed ice-film, and means for removing the excess water from the ice and for recirculating the same over said surface.

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